Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

October 28, 1960

BIOLOGICAL EVALUATION

SPRUCE BUDWORM INFESTATIONS
1960

Carson and Santa Fe National Forests and Adjacent
Private Land and Navajo Indian Reservation

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The spruce budworm egg mass survey on National Forest, private and Indian lands in north-central and northwestern New Mexico was initiated August 15 and concluded September 23. F. M. Yasinski delineated the infestation during the aerial survey.

On the basis of the 1959 egg mass counts 1/, the ensuing damage in 1960 and the 1960 egg mass densities, moderate to heavy defoliation of new growth is forecast for 1961. Intensities of damage increased in 1960. For example, on the Carson and Santa Fe National Forests and adjacent lands, the moderately infested acreage increased 2.5 times; the heavily infested acreage almost doubled; and the severely infested area increased eightfold for a total of 698,000 acres. In addition, 62,560 acres are infested in the Chuska Mountains on the Navajo Indian Reservation. If population trends continue and control measures are not undertaken, extensive tree mortality is imminent.

In 1955, 370,885 acres 2/ of national forest land in north-central New Mexico were treated with Technical Grade DDT at the rate of one pound of the insecticide per gallon of fuel oil per acre of infested forest. This was the first large-scale spruce budworm control project in New Mexico. The acreage infested the following year

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1/ Pierce, D. A. Biological evaluation of spruce budworm infestation, Carson and Santa Fe National Forests and adjacent private land, northern New Mexico. 1959.

2/ Massey, C. L. Results of the spruce budworm project--New Mexico, 1955.

decreased sharply. Since 1956, the infestations have increased to a record high. Acreages infested by the spruce budworm on the Carson and Santa Fe National Forests and adjacent private lands as detected by aerial and ground surveys since 1954 are as follows:

1955	652,955	1958	205,120
1956	35,520	1959	619,920
1957	62,620	1960	697,760

The Tierra Amarilla and the Pecos entomological units 3/ are the only units treated in the 1955 control project remaining relatively free of budworm.

TECHNICAL INFORMATION

Causal agent: Spruce budworm, Choristoneura fumiferana (Clem.).

Host trees: Douglas-fir, Pseudotsuga menziesii var. glauca; white fir, Abies concolor; corkbark fir, Abies arizonica; blue spruce, Picea pungens; and Engelmann spruce, Picea engelmanni. In New Mexico damage is confined for the most part to Douglas-fir and white fir.

Type of damage: In north-central New Mexico the infestations are increasing in intensity; moderate defoliation is most characteristic. In the northwest corner of the state, on the Navajo Indian Reservation, the infestation is gaining in intensity, but is still classed light to moderate.

Environmental factors: No unusual environmental factors are known to be associated with the outbreak.

Extent and location of outbreak: The infestation is confined to northern New Mexico. Approximately 760,000 acres of mixed conifers on federal, Indian, and private lands exhibit varying degrees of defoliation. Areas infested are delineated on the attached maps. Acreages and degrees of defoliation are summarized in Table 1.

BIOLOGICAL EVALUATION

Sampling: Twenty-nine plots for sampling budworm populations were established throughout the infested area--4 on the Navajo Indian

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3/ Bongberg, J. W., and Bennett, R. K. Spruce budworm infestation in New Mexico and Arizona. 1955.

Reservation and 25 on the Carson and Santa Fe National Forests and adjacent private lands. Plot locations are numbered on the maps. A plot consisted of five dominant or codominant trees of one species, either Douglas-fir or white fir. White fir was sampled only at Rio Nutritos and Brazos Box. Two men, using an 18-foot aluminum extension ladder sampled infested trees by removing two lower mid-crown branches. The foliage on one side of each branch was stripped off and discarded; this, in effect, amounted to one whole branch per tree, or five whole branches per plot. The gross area of the remaining foliage on each limb was measured then clipped and placed in numbered plastic bags. The foliage was taken to Taos, New Mexico, and examined for egg masses. Branch samples collected on the Navajo Indian Reservation were examined for egg masses in Albuquerque by laboratory personnel.

Table 1.--Acreage of spruce budworm infestations in Northern New Mexico by Degree of Defoliation.

Location	Degree of defoliation 1/				Totals	
	Light	Moderate	Heavy	Very Heavy	Federal	Private
Carson N. F., Eastern Division and adjacent land						
Forest Service	35,520	114,080	10,880	0	160,480	
Picuris Grant	3,680	0	0	0	3,680 2/	
Rosario Grant	0	1,440	0	0		1,440
Ranch Del Rio Grande	10,240	49,760	0	0		60,000
Maxwell Grant	22,880	8,320	2,240	0		33,440
Mora Grant	960	16,320	0	0		17,280
Carson N. F., Western Division and adjacent land						
Forest Service	11,520	25,280	3,840	0	40,640	
Tierra Amarilla Grant	22,560	27,200	16,640	2,080		68,480
Santa Fe N. F., Western Division and adjacent land						
Forest Service	94,720	40,480	6,400	1,440	143,040	
Polvadera Grant	160	2,240	0	0		2,400
Lobato Grant	3,680	0	0	0		3,680
Baca Location	43,840	8,640	0	0		52,480
Canyon De San Diego	9,440	0	0	0		9,440
Santa Fe N. F., Eastern Division						
Forest Service	62,080	33,440	4,320	1,440	101,280	
Subtotals	321,280	327,200	44,320	4,960	449,120	248,640
Navajo Indian Reservation	24,800	33,760	4,000	0	62,560 2/	
TOTAL	346,080	360,960	48,320	4,960	511,680	248,640

1/ Defoliation categories are Light, defoliation barely visible from the air; Moderate, top one-fourth of tree defoliated; Heavy, one-half of tree defoliated, top-killing in progress; and Very Heavy, three-fourths of tree defoliated, tree killing in progress.

2/ Indian land - federal.

Defoliation estimates: Data on 1960 foliage damage and new bud formation were recorded when the foliage was examined for egg masses. Approximately 170 current-year shoots from each of 3 limbs (about 500 shoots) were randomly selected from each plot and classed as undamaged, damaged, or dead to obtain a relationship between 1959 egg masses and current damage. Using the same sampling method, another 300 expanded shoots per plot were examined to obtain percent of new buds failing to form.

Parasite collections: Late instar larval and pupal parasite collections were made from seven of the 1959 egg mass survey plots during the week of July 4. At that time, approximately 90 percent of the larvae had pupated. Fifty to sixty spruce budworm pupae were collected from each plot and brought into the laboratory to be reared. An unsuccessful attempt was made to rear the few larvae that were collected.

Egg mass density: Egg masses were examined under a microscope and classified into new, old and parasitized. The classification was based on the following rules:

1. Masses containing less than four eggs were not counted.
2. Old parasitized egg masses were disregarded.
3. Masses less than 50 percent of the eggs, the mass parasitized were classified as non-parasitized.

RESULTS

Defoliation estimates: Current Douglas-fir shoots damaged or dead ranged from 21 to 94 percent. On the two plots where both tree species were sampled, white fir had 21 and 22 percent more dead and damaged shoots than Douglas-fir. The average percent of damaged and dead expanded shoots for all plots except on the Navajo Reservation was 54. Twenty-one percent of the expanded shoots failed to form new buds. It was not always possible to attribute this injury to budworm feeding.

Parasite collections: A hymenopterous parasite (probably Glypta fumiferana (Vies.) was reared from cocoons found where budworm larvae had been feeding. It was assumed that the insect was a larval parasite. A tachinid was by far the most common pupal parasite. Three species of hymenopterous parasites were reared from budworm pupae. Specimens of each species are being sent to Beltsville for identification.

The following are budworm parasites collected during 1959:

Parasite	Family	Host Stage
Ceromasia auricaudata (Tns.)	Tachinidae	pupae
Madremyia saundersii (Will)	Tachinidae	pupae
Phryxe pecosensis	Tachinidae	last instar larvae
Aplomya caesar (Ald.)	Tachinidae	last instar larvae
Glypta fumiferana (Vier)	Ichneumonidae	last instar larvae
Phaeogenes hariolus (Cress.)	Ichneumonidae	pupae
Trichogramma minutum (Riley)	Trichogrammatidae	eggs

Egg mass density: The average number of new egg masses per 1,000 square inches of foliage was 34.6 in 1959 and 30.9 in 1960. New egg masses averaged 33.9 on the Navajo forests (Table 2). The ratio of new to old egg masses on the Navajo was 2.7.

DISCUSSION AND CONCLUSION

Defoliation on all plots in 1960 was moderate to heavy. Environmental factors are not expected to change the infestation characteristics in the near future. From the information gathered, it appears that a similar degree of damage will occur in 1961. In addition to the seriousness of the accumulative effect of defoliation, the present boundaries are likely to enlarge.

Sawtimber is being killed over widespread areas both on the Carson and Santa Fe National Forests. Advanced reproduction in many areas on both forests is severely damaged. Control measures are a necessity to protect the present and future timber crop in northern New Mexico.

Table 2.--Summary of spruce budworm egg mass counts from 29 plots on National Forests, private, and Indian land in Northern New Mexico, 1959 and 1960.

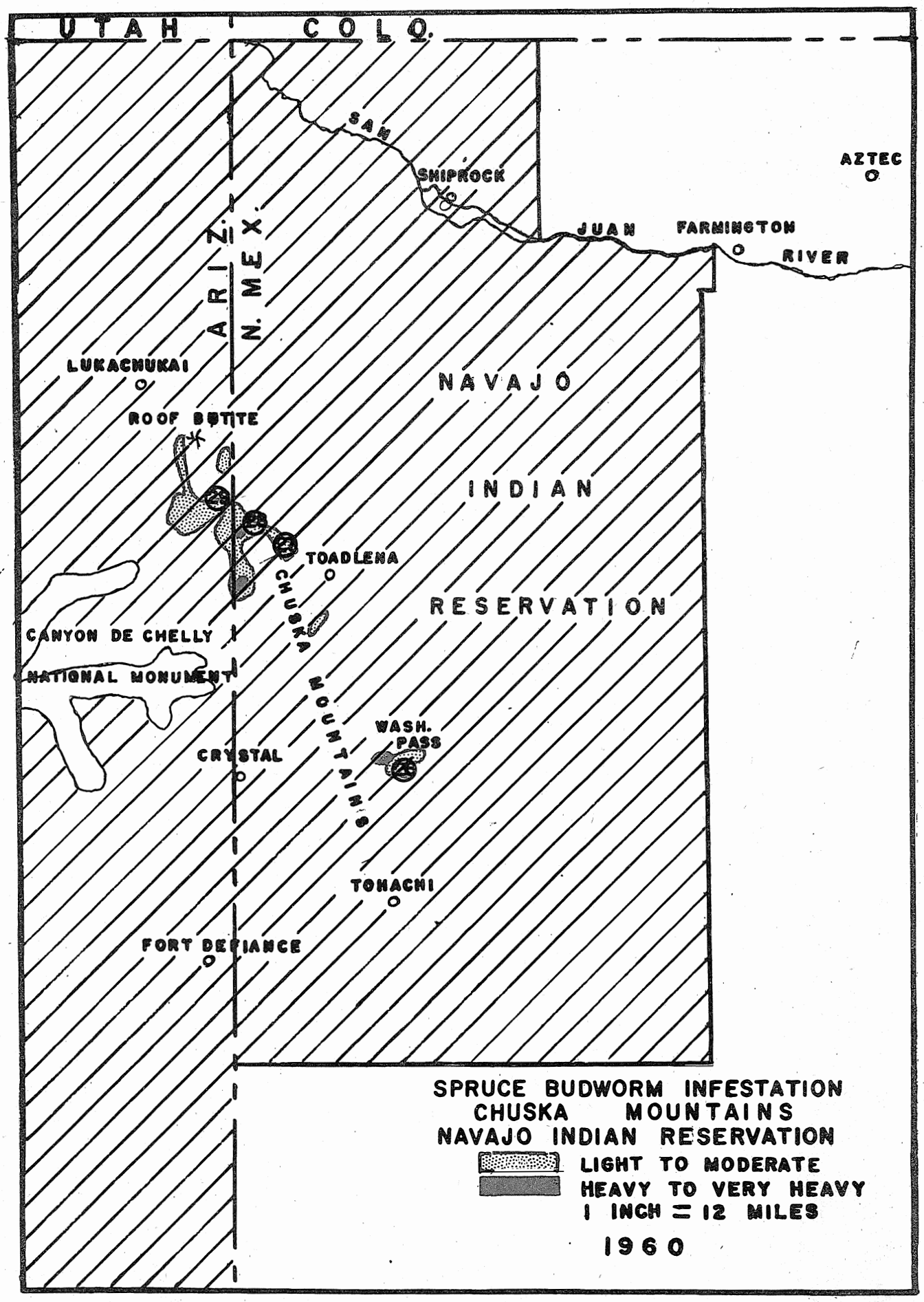
Plot location	Plot no.	Sq. in. of foliage examined 1959	Sq. in. of foliage examined 1960	Number of egg masses per 1,000 sq. in. of foliage 1959 New	1959 Para.	1960 New	1960 Para.
Carson N. F., Eastern Division & adjacent land							
Pot Creek	1	9,817	8,762	32.6	1.3	52.7	7.2
La Junta Canyon	2	12,247	10,365	30.5	0.4	31.4	1.9
Comales Creek	3	9,573	10,365	42.0	1.0	51.4	3.2
Picuris Peak	4	10,665	13,173	54.4	0.2	32.6	2.1
La Jara Canyon	5	11,589	11,229	30.9	0.1	17.5	1.4
Pueblo Canyon	6	8,770	7,597	69.3	1.6	33.0	8.3
Taos Canyon	7	8,879	12,512	70.2	2.5	16.3	2.2
Chiquito Canyon	8	9,907	7,076	61.9	2.3	25.6	1.4
Polio Carpio Canyon	9	0	12,350	----	---	24.3	0.0
Santa Barbara Campground	10	0	8,101	----	---	28.0	0.1
Garcia Park	11	0	12,167	----	---	32.3	4.2
Subtotal		81,447	113,697	391.8	9.4	345.1	32.0
Subaverage		10,181	10,336	49.0	1.2	31.4	2.9
Carson N. F., Western Division & adjacent land							
Lobo Lodge	12	10,106	7,294	23.1	0.0	92.1	4.9
Brazos Box 1/	13	15,129	12,363	4.8	0.0	7.4	0.4
Brazos Box	14	0	10,259	----	---	32.5	0.8
Willow Creek	15	12,032	11,148	21.4	0.0	46.2	3.7
Canones Creek	16	13,292	9,632	13.6	0.1	32.4	4.6
Broke Off Mt.	17	9,590	7,903	29.0	0.0	28.8	0.1
Rio Nutritos 1/	18	0	9,182	----	---	12.2	0.1
Rio Nutritos	19	0	7,795	----	---	30.5	0.9
Subtotal		60,149	75,576	91.9	0.1	282.1	15.5
Subaverage		12,003	9,447	18.4	0.0	35.3	1.9

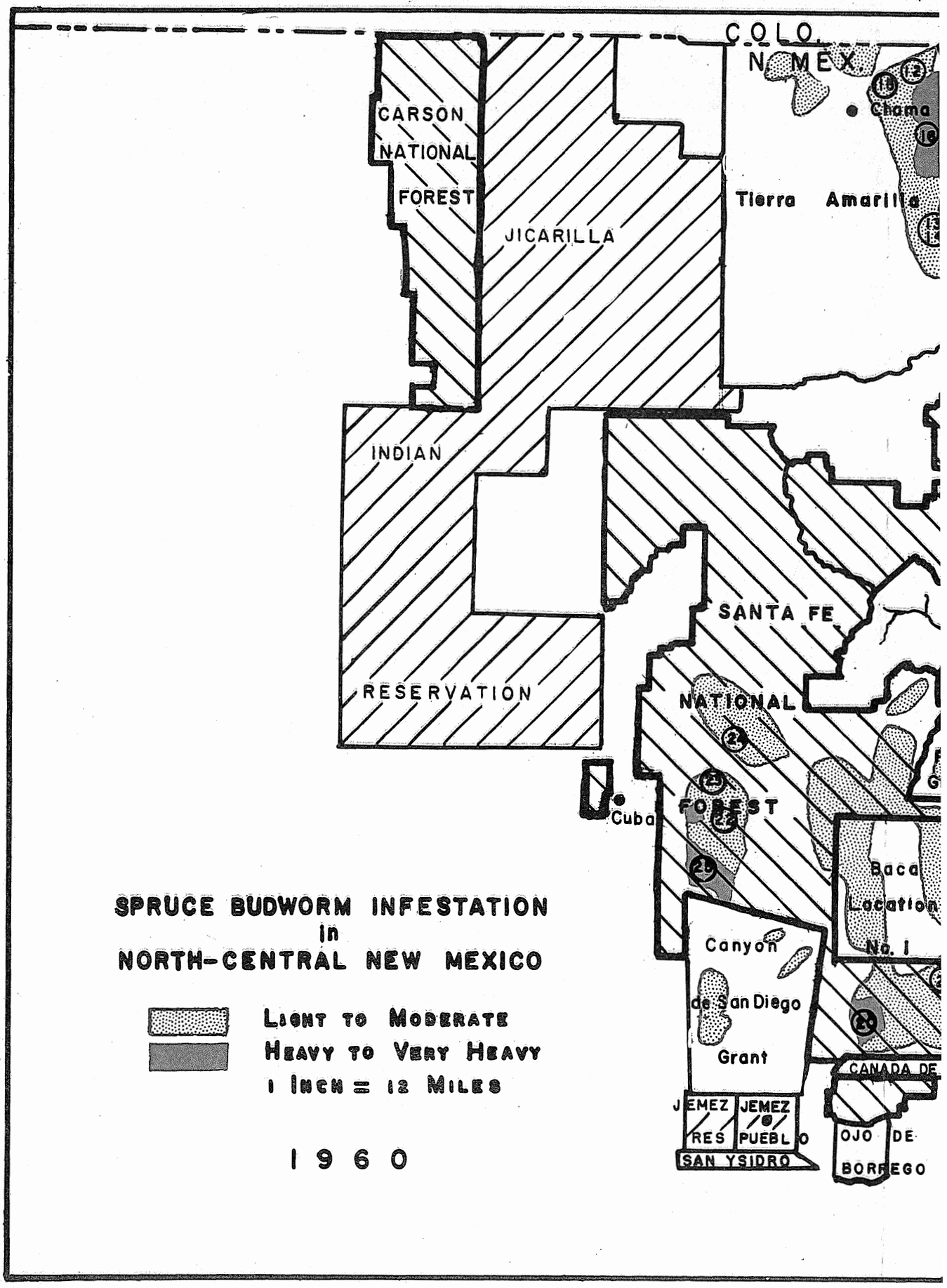
Table 2 Continued

Table 2 - Continued.

Plot location	Plot no.	Sq. in. of foliage examined 1959	Sq. in. of foliage examined 1960	Number of egg masses per 1,000 sq. in. of foliage 1959 New	1959 Para.	1960 New	1960 Para.
Santa Fe N. F., Western Division & adjacent land							
Paliza Canyon	20	15,805	8,141	33.5	0.1	63.0	2.3
Del Norte Canyon	21	20,678	12,081	16.3	0.0	6.8	0.0
Clear Creek	22	10,445	9,839	17.8	0.0	3.6	0.1
Blue Bird Mesa	23	9,886	7,968	44.8	0.4	12.9	0.3
San Pedro Mts.	24	11,774	13,225	26.3	0.0	23.1	0.3
Red Top	25	0	7,191	----	---	35.4	0.3
Subtotal		68,588	58,445	138.7	0.5	144.8	3.3
Subaverage		13,718	9,741	27.7	0.1	24.1	0.6
Grand Total		210,184	247,718	622.4	10.0	772.0	50.8
Grand Average		11,677	9,909	34.6	0.6	30.9	2.0
Navajo Indian Reservation							
Washington Pass	26	0	9,314	-----	---	34.2	3.5
Toadlena	27	0	10,930	-----	---	20.4	0.4
Burn	28	0	9,517	-----	---	58.3	3.7
Roof Butte	29	0	11,292	-----	---	22.8	2.7
Total		0	41,053	-----	---	135.7	10.3
Average			10,263	-----	---	33.9	2.6

1/ White fir sample.


UTAH
COLO.
ARIZ.
N. MEX.
SAN JUAN RIVER
SHIPROCK
AZTEC
FARMINGTON
LUKACHUKAI
ROOF BUTTE
NAVAJO
INDIAN
RESERVATION
TOADLENA
CHUSKA MOUNTAINS
CANYON DE CHELLY
NATIONAL MONUMENT
WASH.
PASS
CRYSTAL
TOHACHI
FORT DEFIANCE
SPRUCE BUDWORM INFESTATION
CHUSKA MOUNTAINS
NAVAJO INDIAN RESERVATION
LIGHT TO MODERATE
HEAVY TO VERY HEAVY
1 INCH = 12 MILES
1960



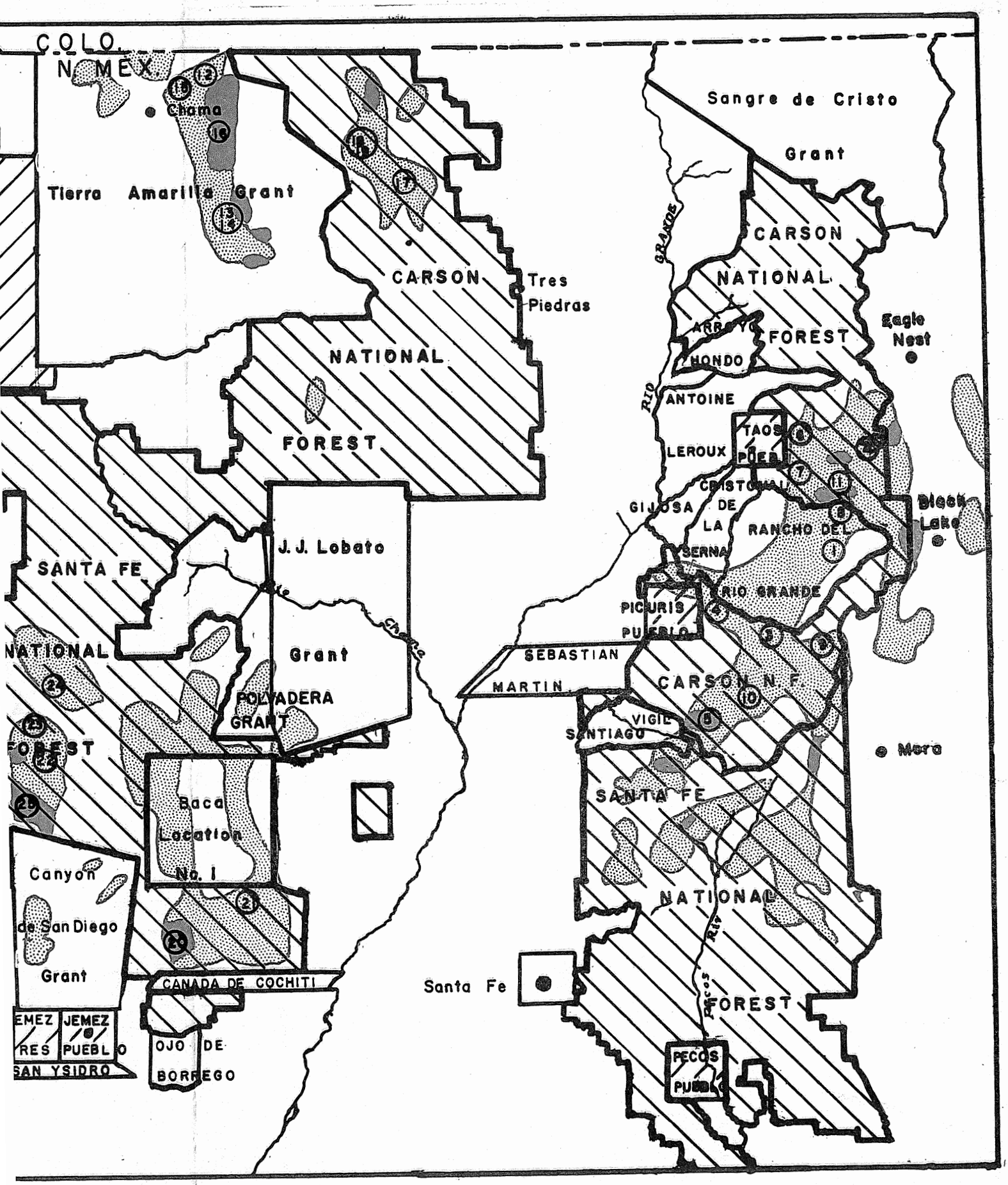
SPRUCE BUDWORM INFESTATION in NORTH-CENTRAL NEW MEXICO

LIGHT TO MODERATE

HEAVY TO VERY HEAVY

1 INCH = 12 MILES

1960


COLO.
N. MEX.
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Tierra Amarilla Grant
CARSON
NATIONAL
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Tres Piedras
SANTA FE
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J. J. Lobato
Grant
POLVADERA GRANT
Baca Location No. 1
Canyon de San Diego Grant
CANADA DE COCHITI
JEMEZ RES
JEMEZ PUEBLO
SAN YSIDRO
OJO DE BORREGO
Sangre de Cristo Grant
CARSON NATIONAL FOREST
RIO GRANDE
ARROYO HONDO
ANTOINE LEROUX
TAOS
POEB
CRISTOBAL
GIJOSA DE LA SERNA
RANCHO DEL
Eagle Nest
Black Lake
RIO GRANDE
PICURIS PUEBLO
SEBASTIAN MARTIN
CARSON N.F.
VIGIL SANTIAGO
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SANTA FE NATIONAL FOREST
Santa Fe
PECOS PUEBLO